What is claimed is:

1) A process for the production of microcellular nanocomposite or molecular-composite polymer foam shape comprising:

a) saturating a consolidated nanocomposite or molecular-composite polymer shape with an inert gas at an elevated pressure above and at a temperature above the glass transition temperature of the polymer;

b) fully or partially releasing the pressure; and

c) controllably quenching the nanocomposite or molecular-composite polymer shape to a temperature below the glass transition temperature of the polymer.

2) The process of claim 1 wherein said quenching is performed by reducing the temperature of the polymer shape to below the glass transition temperature of the polymer while maintaining said elevated pressure in an inert atmosphere.

3) The process of claim 1 wherein said quenching is performed by partially reducing said elevated pressure, cooling said polymer shape to a temperature below the glass transition temperature of said polymer, and reducing the pressure to ambient.

4) The process of claim 1 wherein saturating is performed at a pressure above about 1000 psi.

5) The process of claim 1 wherein said inert gas is selected from the group consisting of nitrogen, argon, helium, and carbon dioxide.

6) The process of claim 1 said polymer shape is consolidated prior to saturating by the application of pressure above about 8000 psi when said consolidation is performed at room temperature.

7) The process of claim 1 wherein said nanocomposite or molecular-composite is blended with a solvent prior to consolidation.

8) The process of claim 8 wherein said nanocomposite or said molecular-composite is blended with from about 50 to about 150 weight percent of said solvent prior to consolidation.

9) A microcellular nanocomposite or molecular-composite polymer foam shape produced by a process comprising:

a) saturating a consolidated shape of a nanocomposite or molecular-composite polymer to be foamed with an inert gas at an elevated pressure above and at a temperature above the glass transition temperature of said polymer;

b) fully or partially releasing the pressure; and

c) controllably quenching said polymer shape to a temperature below the glass transition temperature of the polymer.

10) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said quenching is performed by reducing the temperature of the nanocomposite or molecular composite polymer shape to below the glass transition temperature of the nanocomposite or molecular composite polymer while maintaining said elevated pressure in an inert atmosphere.

11) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said quenching is performed by reducing the temperature of the nanocomposite or molecular-composite polymer shape to below the glass transition temperature of the nanocomposite or molecular-composite polymer while maintaining said elevated pressure in an inert atmosphere.

12) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said wherein saturating is performed at a pressure above about 1000 psi.

13) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said inert gas is selected from the group consisting of nitrogen, argon, helium, and carbon dioxide.

14) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said nanocomposite or molecular-composite polymer shape is consolidated prior to saturating by heating said polymer to its softening point under an inert atmosphere and a pressure above about 8000 psi.

15) The microcellular nanocomposite or molecular-composite polymer foam of claim 9 wherein said polymer shape comprises up to about 30 weight percent of a filler selected from the group consisting of chopped glass fibers, carbon fibers, metallic fibers, aramid fibers, ceramic whiskers, ceramic fibers and calcium carbonate powder.

16) The microcellular nanocomposite or molecular-composite foam shape of claim 9 wherein said nanocomposite or molecular-composite is blended with a solvent prior to consolidation.

17) The microcellular nanocomposite or molecular-composite foam shape of claim 16 wherein said nanocomposite or said molecular-composite is blended with from about 50 to about 150 weight percent of said solvent.

18) The microcellular nanocomposite foam shape of claim 9 wherein said nanocomposite is selected from the group consisting of blends of nanofibers or nano powders with a polymer and polyhedral oligomeric silsesquioxanes.

19) The microcellular molecular-composite foam shape of claim 9 wherein said molecular-composite comprises rigid rod polymer molecules dispersed in a matrix of a flexible coil polymer at the molecular level.

20) The microcellular molecular-composite foam shape of claim 19 wherein said molecular-composite comprises a member selected from the group consisting of the p-terephthaloylamide/nylon system, the poly-p-phenylenebenzobisthiazole/poly-2, 5 (6)-benzimidazole system and the polybenzobisthiazole (PBZT) and 2-sulfo-PBI rigid-rod polymer systems.

21) The microcellular molecular-composite foam shape of claim 19 wherein said rigid rod polymer comprises a polymer selected from the group consisting of polybenzimidazole (PBI), sulfopolybenzimidazole (2-Sulfo-PBI), polybenzobisthiazole (PBT), sulfopolybenzobisthiazole (SPBT), sulfopolybenzobisthiazole (SBPPBT), polybenzobisoxazole (PBO), hydroxy functionalized copolymer of polybenzoxazole (HPBO), and polyimide.

22) The process of claim 1 wherein said nanocomposite is selected from the group consisting of blends of nanofibers or nano powders with a polymer and polyhedral oligomeric silsesquioxanes.

23) The process of claim 1 wherein said molecular-composite comprises rigid rod polymer molecules dispersed in a matrix of a flexible coil polymer at the molecular level.

24) The process of claim 1 wherein said molecular-composite comprises a member selected from the group consisting of the p-terephthaloylamide/nylon system, the poly-p-phenylenebenzobisthiazole/poly-2, 5 (6)-benzimidazole system and the polybenzobisthiazole (PBZT) and 2-sulfo-PBI rigid-rod polymer systems.

25) The process of claim 23 wherein said rigid rod polymer comprises a polymer selected from the group consisting of polybenzimidazole (PBI), sulfopolybenzimidazole (2-Sulfo-PBI), polybenzobisthiazole (PBT), sulfopolybenzobisthiazole (SPBT), sulfopolybenzobisthiazole (SBPPBT), polybenzobisoxazole (PBO), hydroxy functionalized copolymer of polybenzoxazole (HPBO), and polyimide.